ONTARIO WATER RESOURCES COMMISSION

ICING OF MECHANICAL AERATORS ON LAGOONS UNDER COLD CLIMATE OPERATING CONDITIONS

DIVISION OF RESEARCH
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INTRODUCTION

This paper investigates the possibility of icing problems occurring in the operation of mechanical surface aerators on lagoons in the Northern Ontario climate. It is not within the scope of this paper to deal with treatment efficiency under these low temperature conditions but rather the likely problems that may occur due to icing and possible means of overcoming these problems.

As there are no such installations in existence in Northern Ontario, the information presented in this paper has been derived from literature on existing installations in similar climates in other parts of Canada and through personal correspondence with personnel responsible for the operation of these installations, as well as with equipment manufacturers.

HOW DOES ICING CONSTITUTE A PROBLEM?

Under cold weather conditions, problems with icing will first occur as a result of spraying water freezing and bridging across the supporting structure or upon the impeller itself. In the case of a permanent structure such ice formations may not hamper the efficient operation of the aerator. In the case of floating aerators, however, the added weight may increase the submergence of the impeller or cause the aerator to tip. In either case the efficiency of the aerator is reduced.

Under extremely cold conditions, icing may be such that the rotation of the impeller itself is restricted due to a massive buildup of ice on the supporting structure. In this case, efficient operation of the aerator is impossible and it must be taken out of operation until warmer weather prevails.

In the case of aerators with draft tubes, frazil ice formation will likely constitute a problem if the temperature of the liquid is depressed below 35°F.

CONSTRUCTION OF LAGOON TO MINIMIZE HEAT LOSS

Heat loss from the aerating liquid occurs primarily through the liquid-air interface, and the resulting temperature, as well as being dependent upon the ambient temperature, is also highly dependent upon the incoming liquid temperature and the retention time of the lagoon.

As little can be done about the initial temperature of the waste, the lagoon should be constructed as close as possible to the waste source to minimize heat loss in transit to the lagoon.

Since treatment efficiency is dependent upon both detention time and liquid temperature, increasing with detention and decreasing with temperature, an optimum condition may be reached between the two, keeping in mind that increasing the detention time will increase the heat loss.

Since heat loss occurs through the liquid-air interface, increasing lagoon depth to reduce surface area at a given detention will tend to minimize this heat loss.

One partial solution to the heat loss problem is to construct two aerated lagoons of equal volume with piping adequate for either series or parallel operation. During warm weather and until icing constitutes a problem the lagoons are operated in parallel. When icing becomes a problem the lagoons are switched to series operation and the second aerator is turned off. In this way the retention of the first lagoon is decreased by one-half and the heat loss within it will possibly be reduced to a limit to allow continuous operation of the aerator. Ice is allowed to buildup on the second lagoon.

Mechanical surface aerators used in lagoons which have not been specifically designed for cold weather operation may lower the basin contents to the freezing point. The only satisfactory solution to this situation is to remove the aerator from service until conditions again permit its operation.

SELECTION OF AERATION EQUIPMENT

The selection of aeration equipment depends to a major extent upon whether the lagoon is to be operated as an anaerobic-aerobic or as an aerobic system. For cold weather operation however, the aeration device must be properly designed to ensure that any floating ice on the surface of the lagoon is always made to move away from the impeller.

Anaerobic-Aerobic Systems

Successful operation of anaerobic-aerobic systems depends upon maintaining an aerobic layer of water of sufficient depth to prevent the release of obnoxious gases at the air-water interface. It does not depend upon mixing velocities sufficient to prevent solids deposition, but rather what might be termed "bathing velocities" sufficient to dissolve the products of anaerobic digestion at the sludge-water interface and carry them into the aerobic zone for destruction by aerobic bacteria.

Surface aerators of practically any design are adequate for anaerobic-aerobic systems provided that they have the capacity to supply sufficient oxygen to satisfy the total oxygen demand of the waste.

Aerobic Systems

Successful operation of aerobic systems depends upon providing adequate mixing to maintain essentially all biological growths in suspension at all times. This requires that flow velocities in the major portion of the bottom of the lagoon must be adequate to prevent deposition of solids. Acceptance of any aeration device should be based upon performance tests. In very deep lagoons, aerators with draft tubes or deep secondary propellers may be required.

SELECTION OF MOUNTING EQUIPMENT

For operation in cold climates, mechanical surface aerators should be mounted on permanent structures rather than floating platforms unless adequate provision is taken to prevent the buildup of ice on the latter. A buildup of ice on the floating platform will add weight to the system and increase the submergence of the impeller.

As problems with icing result when spraying water freezes and bridges across the supporting structure, the platform and supporting pillars should be out of reach of the spray caused by the aerator unless anti-splash guards are installed. In any case, a minimum height of platform from the water surface, as well as extent of platform, may be established for a given aerator. It may also be advisable to use three or even two column supports rather than the conventional four. Guide-lines and struts should be avoided where possible.

Under the most severe conditions, heated housings should be installed to prevent ice from building up on any part of the aerator and platform.

COLD WEATHER OPERATION OF AERATED LAGOON

In extremely cold climates, when the temperature of the aerated liquid is likely to fall below 33-34°F (1°C), it is questionable whether there would be any advantage in

operating the aerator. At these temperatures, the activity of the bacteria is extremely low, supplemental oxygen becomes unnecessary and the action of the aerator lowers the temperature even further resulting in even lower bacterial activity.

Under these conditions the selection of equipment and design of the lagoon should be such as to minimize heat loss and ice formation in order that the operation of the aerator may be continued as long as possible. The aerator is turned off manually when icing begins to occur in early winter and back on, again manually, when the temperature begins to rise in the spring. Under no conditions should the aerator be turned back on without checking that the impeller is free to rotate.

In less severe climates, where prolonged periods of sub-zero temperatures are uncommon, the aerator can be kept running throughout the winter season. In this case the heated housing may be necessary to prevent icing during the more severe conditions.

Since heat loss from the liquid occurs through the liquid-air interface and is greatly enhanced by the mixing action of the aerator, the aerator may be programmed to operate intermittently during those conditions of severe temperature. The aerator should be turned on frequently enough to keep it from freezing solid so that it may again be operated continuously when conditions improve.

EXISTING COLD CLIMATE INSTALLATIONS

The existing installations of mechanical surface aerators in lagoons in cold climate appear to all have been constructed for use in treating pulp and paper plant effluents. The incoming waste temperature is therefore generally in the order of 70°F in comparison to the 50-60°F (12°C) expected for domestic wastes. Detention times, however are as high as eight days as compared to the two to three day detention time for domestic waste treatment facilities.

The following table summarizes the pertinent data on five such installations. The location of the plant is given as well as the location in Ontario where one would expect to find a similar climate.

Although problems were initially experienced at several of these installations, these have been corrected and all appear to be now operating throughout the winter without any particular operating problems due to icing.

At Kamloops Pulp and Paper Co. Ltd., Kamloops, B.C., initial problems due to excessive splashing were encountered with the floating platform aerators. Subsequently, anti-splash guards were installed between the styrofoam pontoons to completely enclose the aerator platforms and during a two week mill shutdown during December 1966, the aerators were kept running with no icing problems occurring even with the ambient temperature being around -4°F.

EXISTING INSTALLATIONS

Location	Climate*	Aerator	Detention	Problems
Hinton, Alberta	Timmins	Welles-floating	4 days	No problems encountered even though temperatures reached an extreme of -25°F.
Prince George, B.C.	North Bay	Lightnin-fixed	1 day	No problems even though temperatures remained below -20°F for a period of 2 weeks.
Prince George, B.C.	North Bay	Simcar-fixed	1 day	No problems with operation of aerators
Kamloops, B.C.	Toronto	Simcar-floating	5 days	Problems with icing initially and splash guards had to be installed to protect floats. No subsequent problems.
Portage du Fort, Quebec	Ottawa	Simcar-fixed	8 days	No problems with icing of aerators.

* Location of similar climate in Ontario.

Prince George Pulp and Paper Ltd., Prince George, B.C. has experienced small ice buildups on the four concrete columns supporting the aerator platforms under their most severe conditions, but in no way have these affected the operation of the aerators.

CONCLUSIONS

Consideration of each potential application of an aerated lagoon must be based on the conditions that exist, the detention time, the influent temperature, the amount of treatment that is expected or predicted, the climate, etc.

Once it is decided to construct an aerated lagoon much can be done to minimize icing problems through proper design and location of lagoon, selection of aeration and mounting equipment and operation of the lagoon system. Any problems encountered due to icing, except perhaps under the most extreme conditions, may be overcome through heat housings, operational changes, etc.

There may be certain conditions of waste and climate where it would be impossible to effectively operate an aerated lagoon. A thorough investigation of each proposed system will determine whether these conditions exist.

Aerated lagoons are being operated successfully in cold climates and even though problems with icing have sometimes been encountered, these have quite easily been overcome. There

DATE	ISSUED TO

is no reason to believe, except under the most extreme conditions, that icing of mechanical aerators should become an insurmountable problem in the operation of aerated lagoons in the Northern Ontario climate.